Designing an Educational Music Game: What if Children Were Calling The Tune?

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Abstract

This paper presents the design process of an educational digital music game that offers primary school children a first experience with music education. A four-phased Participatory Design (PD) trajectory was followed: exploratory interviews, Proxy Technology Assessment using the MemoLine instrument, co-design sessions and evaluation of the first demonstrator. This paper describes how PD principles can be used in obtaining design requirements for educational digital music games for children. The results highlight children's desired game features for an educational music game. These include a clear feedback loop, a reward structure based on performance and persistence, chunking of learning content, an autonomous learning path, room for creativity and providing a 'private' practice space while allowing public performance.

Keywords: Games; Music Education; Digital Game Based Learning; Participatory Design; Children.

1 Introduction

Digital music games are increasingly being developed for educational purposes, like learning to sing, play the piano or read music. Gradually, these games are being recognized as active learning environments: they have the potential to instill motivation in users and allow engagement while playing (Denis & Jouvelot, 2005; Peppler, Downton, Lindsay, & Hay, 2011). When designing technologies for children, researchers in the field of Child-Computer Interaction (CCI) (e.g. Druin, 2002; Hanna, Neapolitan, & Risden, 2004) have advocated for the involvement of children. Participatory Design (PD) is an approach to design relating to the involvement of end-users as full participants in the design and research process. This approach starts from the conviction that people have the right to participate in the design of a technical system of their (potential) concern, and therefore stimulates designing *with* - instead of *for* – people (e.g. Ehn & Badham, 2002). By stimulating participation with children and involving them in the design process (Iversen, 2005; Read, Fitton, & Horton, 2014), the final design is found to benefit from the children's input as they contribute with ideas that adult designers do not consider otherwise. However, working with children in PD processes can be challenging (Iivari, Kinnula, & Kuure, 2015; Read et al., 2002), despite the continuous development of numerous PD methods for involving children (e.g. Fails, Guha, & Druin, 2012; Guha, Druin, & Fails, 2013; Vaajakallio, Mattelmäki, & Lee, 2010). When designing serious games, the challenge lies within building a theoretical framework at the start of a project so

that children can contribute with useful design input and gain a valuable learning experience (Khaled & Vasalou, 2014).

In this paper, we describe how children were involved in the design of an educational digital music game for primary school children. The goal of this PD process was to identify how digital games can help novice learners to learn to sing in an informal setting. We chose to focus on singing since it is an activity all children, regardless of other resources, can engage in. More specifically, the focus was on singing pitches correctly, in line with rhythm and song structure. Since the game was envisioned to be used in an informal setting, we made sure to include features that turn learning into play instead of education (Ronimus & Lyytinen, 2015). Furthermore, we aimed to lower the learning threshold in Flanders (i.e. the Dutch speaking region in Belgium) where formal music education does not correspond with children's musical practices as teachers mainly focus on classical music (Bamford, 2007).

The game was developed by a company specializing in content for hybrid and digital games, and a company focusing on audio analysis. The project resulted in a mobile game application (depicted in figure 1 and available in the App Store since March 2015) to which we will refer as the 'MELoDiA' game throughout this paper. The game uses audio analysis technology to detect (in)correct pitches and rhythm, allowing for accurate real-time feedback on the user's performance. The application offers a show mode, a rewarding system, and playful practice opportunities to support motivation.

The game incorporates songs of the popular Flemish girl band K3. Due to a change in project partners during the project, the focus shifted from 8 to 12 year-old children to 6 to 10 year-olds. Consequently, children of age ranges across all classes of primary school were involved.

(insert figure 1)

Figure 1. Practice mode and modes menu (copyright Cartamundi Digital)

In the field of CCI, little attention has been paid to applying PD principles in obtaining design requirements for educational digital music games for children. As such, the results of this paper can inform future designers interested in educational music game design.

2 Theoretical framework

At the start of the project, we defined 14 principles that informed the game design. These were based on Digital Game Based Learning (DGBL), self-determination theory (SDT), three learning theories (constructivism, 9 events of instruction, chunking) and insights from current music education practices. They served as the basis to involve children as experts of their own learning experience (Visser, Stappers, van der Lugt, & Sanders, 2005) and were later visually translated in conceptual elements.

Literature on DGBL argues that digital games can instill learning experiences (e.g. Prensky, 2007) in different learning fields, as these can respond to the intrinsic motivation of learners when the tasks are interesting and fit the learners' abilities (e.g. Gee, 2007). In line with SDT (Deci & Ryan, 1985) games can be intrinsically motivating when they make users feel competent, autonomous and provide psychological relatedness.

In relation to music education, three learning theories support the potential of digital games in music education. First, Becker (2007) links DGBL practices to constructivist principles on active learning, in which understanding and knowledge of the world is constructed through experience and reflection on those experiences. This is relevant to music education, as pupils need to not only recognize but also *experience* five essential music elements; i.e., duration, pitch, tone color, dynamics and structure (Russell-Bowie, 2008). Second, nine events or conditions that define successful instruction (Gagné, 2005) support learners' evaluation and improvement of skills. These can be translated into music game elements such as informative feedback on important errors (Duysburgh, Slegers, Mouws, & Nouwen, 2015), and gaining the learner's attention by making use of popular content that fit children's current musical interests. Learning music can be discouraging and cause drop-out when music learners are not familiar with the teaching material (Lamont, Hargreaves, Marshall, & Tarrant, 2003). Digital music games that make use of popular content can, instead, connect the learning experience to children's musical practices (Green, 2009).

Third, by focusing on important information, the chunking theory of learning (Miller, 1956) reduces cognitive load. By rehearsing one song element at a time, e.g., text, pitch or rhythm (Duysburgh et al., 2015), music games allow players to learn quickly and effectively. We refer to an overview of these theoretical principles in relation to the research insights and design impact at the end of this paper (cf. table 2).

3 Methodology

For the design of the MELoDiA game, we engaged with primary school children in different PD activities in four phases. Figure 2 gives an overview of these research activities in relation to the game design. In the first phase, we interviewed children about their current musical practices (1) and evaluated the conceptual elements based on the theoretical principles (A) with them. We also introduced an existing music game the children played for the proxy technology assessment. Based on the insights from phase 1, the game design company made a first version for the game design that we presented as mock-up images (B) to children during a second visit (2). We also executed the proxy technology assessment using the MemoLine instrument. Based on the insights gained in this phase, we selected several conceptual elements that would guide the further design process. In phase 3, we organized co-design activities to generate new ideas to define game functionalities (3). These were integrated in a demonstrator (C), which we evaluated (4). Ultimately, the game design company integrated the feedback from the children in the final game design (D). Throughout our research, we engaged children and classes with different levels of experience

with music education. We present an overview of the involved participants in table 1 and provide further details about their participation in the description of the phases below.

(insert Figure 2)

Figure 2. Schematic overview of the PD and design process

(insert Table 1)

Table 1. Overview of the participants

3.1 Phase 1 & 2: Exploring children's music learning experience

3.1.1 Phase 1: exploratory interviews (Month 2)

3.1.1.1 Participants

Via the research groups' networks we recruited and interviewed 16 children (in 10 families), aged 8 to 12. Since the music game under development was aimed at novice learners, all children had an interest in and maximum two years of music education. These children were visited at home twice. Although occasionally other family members expressed their opinions, the focus of the interviews remained on the children at all times.

3.1.1.2 Procedure

The researchers inquired about the children's music experiences; i.e., experiences with (in)formal music education, their motivation for (not) taking music lessons, the music they like, and their gaming experiences. Next, the researchers discussed several conceptual elements based on the literature visualized in sketches (see figure 3). Each interview lasted about 50 minutes.

(insert figure 3)

Figure 3. Two concept sketches: popular content & sharing performance

At the end of the interview, the children downloaded the music game 'Piano Dust Buster 2' on a tablet as part of a Proxy Technology Assessment (PTA). In a PTA users reflect on a future technology by making use of existing technologies that share characteristics with the technology under development (Bleumers, Naessens, & Jacobs, 2010). The PTA game resembled the consortium's concept since it was a mobile educational music game (to learn to play the piano) that provided immediate feedback, and used popular content (see figure 4). The children were invited to play the game for four months, without specific instructions on when or how often to play.

(insert figure 4)

Figure 4. Screenshots of the PTA game with (top) immediate feedback and (bottom) popular content (copyright JoyTunes)

3.1.1.3 Analysis of phase 1

We followed a qualitative data analysis approach (Meyer & Avery, 2009) using Google Sheets to support collaborative work. Four researchers paraphrased the audio recordings of their home visits, anonymizing the participants' information (C=child, F=family). Text abstracts were placed in one column and meaningful quotes were placed in an adjacent column. Then, each researcher coded the transcripts of their own recordings. In phase 1, the codebook contained the different conceptual elements (see first column table 2). The codes were added in the columns adjacent to the quotes column.

Next, the data were reorganized in tabs related to the codebook and discussed among the researchers. At the end of analyzing phase 1, we summarized the findings for each conceptual element to the project consortium (cf. section 4 for more results). The game design company used this input to make the first visual designs of the music game.

3.1.2 Phase 2: PTA & long-term UX evaluation (Month 6)

During the second home visit, we evaluated the long-term user experience of the children with the PTA game to understand their experiences beyond first use and perceived learning experience. Furthermore, the children gave feedback on the mock-up images of the first version of the music game under development.

3.1.2.1 Participants

The participants of phase 1 also participated in phase 2. Four months passed between the first and second visit.

3.1.2.2 Procedure

We evaluated the children's experience with the PTA game over four months by using MemoLine (Vissers, De Bot, & Zaman, 2013), a child-friendly instrument based on the UX curve (Kujala, Roto, Väänänen-Vainio-Mattila, Karapanos, & Sinnelä, 2011) to measure long-term user experience. The instrument is used retrospectively to understand *why* experiences change over time. Retrospective studies are less time consuming than longitudinal research designs and account for more than the simple sum of momentary experiences (Sim et al., in press). When using this instrument, researchers rely on participants' memory recall during a single contact moment. Memory biases may occur. However, since

memories of events guide future behavior, memories are more important than the experience itself (Norman, 2009).

The MemoLine was adopted in its original design. We reformulated the questions related to four game experience constructs to gather relevant insights: (1) did you like/dislike playing the game, (2) did you like/dislike the songs you could play, (3) how challenging/not challenging was playing the game, (4) how often did you play (often/not often). Each question was presented to the children on a separate paper timeline that represented the period of use (four months). Recognition points were marked on the timelines (e.g. holidays). Children could respond to the questions by coloring different areas: green for a positive experience, red for a negative one or grey in case of no play. In figure 5 we depict an empty and colored MemoLine.

(insert figure 5)

Figure 5. (top) Example of MemoLine instrument, (bottom) example of completed MemoLine

Before coloring the MemoLine timelines, we asked the children to play the PTA game while talking out loud. We mentioned truthfully that we had not played this game extensively ourselves, to establish the children's role as experts of the game. Next, for training purposes, the researchers colored two timeline areas in consultation with the children, related to their favorite toy. Then, the children colored the remaining timeline. After training, the children colored the four timelines related to the PTA game. For each timeline, the researchers read the question and answer options out loud. The researchers also inquired about

motivations behind transitions between color areas (e.g. Why was the game not challenging anymore?). We relied on these verbal reports to understand how to motivate children to play a game over an extended period of time while sustaining a learning trajectory. Finally, the children answered additional questions (e.g. about perceived learning outcomes). Each interview lasted about 40 minutes.

After evaluating the PTA game, we introduced the visual designs of the MELoDiA game, presented as mock-up images. We presented these on a laptop to support a play simulation of the game (i.e., logging in, practicing a song, interpreting feedback, performing a song). Figure 6 depicts the first attempt to present feedback on the children's performance by using colors (e.g. the yellow curve shows correct pitch, while the red dotted line shows children's performance). The children were asked to share their opinions about each mock-up. They navigated from image to image by touching the laptop's screen, while the researchers used the arrow keys to advance to the next image. All sessions were audio recorded.

(insert figure 6)

Figure 6. Mock-up image showing first iteration for presenting feedback

3.1.3 Analysis of phase 2

We followed the qualitative data analysis approach (Meyer & Avery, 2009) as described in phase 1, following the same steps: paraphrasing audio recordings in a dedicated spreadsheet tab, placing text abstracts in one column and meaningful quotes in an adjacent column, coding the transcripts. In phase 2, the codebook

reflected the MemoLine game constructs (fun, challenge, amount of play) and other themes that emerged during the interviews (e.g. recommendations, skills gained). The codes were added in the columns adjacent to the quotes column.

Next, the data were reorganized in tabs according to the codebook and discussed among the researchers. The analysis focused on distinctions and conformity in the reports of the children, to assess motivational aspects in game play to support music learning.

At this point in the research process we had gained insight into user perspectives on the theoretical principles, need for feedback and motivational issues (cf. section 4 for more results). In the next phase, the goal was to concretize and specify the general expectations formulated by the children into new ideas for the functionalities of the game.

3.2 Phase 3: Co-design (Month 8 & 9)

3.2.1 Participants

We involved a class of 17 children, aged 8 to 12 in co-design sessions at a primary school where music is central in the learning process. In co-design activities, designers and people not trained in design creatively work together (Sanders & Stappers, 2008). Considering the role music takes in their education, we believed these children were especially fit to think about solutions for music learning. The teacher was present in the classroom to supervise the children and, to a limited extent, moderate the sessions together with three researchers (two

moderators and one note-taker). We used video, photographs and written notes for documentation.

3.2.2 Procedure

The researchers used a three-phased methodology inspired by Van Mechelen, Laenen, Vanden Abeele, & Zaman (2015). Firstly, we organized a 1-hour long *introductory session* to present the project and hand over 'sensitizing' packages to the participants, two weeks before the first co-design session. With these packages, the children could express their personal experiences and ideas related to music learning and gaming. We provided three colored envelopes with assignments to be completed by the participants. The envelopes each contained a(n) (written) assignment, blank paper to write on and red and green stickers to indicate (dis)likes. Through the assignments, the participants were asked to visualize themselves while engaging in musical activities and playing a game, and indicate what they did (not) like about music and gaming. In the third assignment, the children had to interview a friend or family member to find out what this person (did not) like(d) about music and games.

The researchers collected the assignments one week before the co-design sessions. 16 participants completed the first assignment, 14 completed the second one, and 15 participants completed the third assignment (see figure 7). During the first session, the participants discussed their assignments for the first 15 minutes. In this way, the sensitizing packages 'warmed up' the participants to be better able to access their personal experiences, and to express their ideas on

the topic of the co-design sessions (Van Mechelen, Gielen, vanden Abeele, Laenen, & Zaman, 2014).

(insert figure 7)

Figure 7. Sensitizing packages: assignment & outcome

After 'sensitizing', we organized a 2-hour *problem-defining session*. The class was divided in four groups of four children. They collaboratively depicted (by e.g. drawing or crafting) what they considered to be problematic about learning music. The session resulted in four artifacts (one per group). For instance, one group crafted a paper doll that represented complex and long-lasting exercises in boring music lessons (see figure 8). The session ended with a 'show-and-tell' and discussion of the artifacts.

(insert figure 8)

Figure 8. Example of problem definition: complex exercises and boring music lessons

One week later, the children worked in the same four groups during a *prototyping session* (lasting 2,5 hours). They were asked to collaboratively find a solution to the problematic music learning experiences they had defined in the previous session, in the form of a game. The session enabled them to express their ideas, and acquire a sense of shared ownership of the resulting design (Muller, 2002). Each group made one low-tech paper prototype. The group that crafted the doll proposed a digital game that combines football and music (see figure 9). The children explained that when a game makes use of children's

personal interests, such as playing football, a more positive learning experience is created. In this game prototype, the scale is visualised on different balls that children have to 'kick' after hearing a note. When the user clicks on the corresponding note name, the football player shoots the ball into the goal. Each group presented their prototype to the other groups.

(insert figure 9)

Figure 9. (top) Children working on a solution for boring music lessons: (bottom) prototype of a music game making use of children's interests

3.2.3 Analysis

Firstly, the completed sensitizing tasks were transcribed and coded. Secondly, a qualitative content analysis (Flick, 2009) was used to analyze the produced prototypes. Thirdly, the field notes were transcribed and coded. Finally, the video fragments were transcribed. Conversation analysis (Silverman, 2010) was used to analyze the interactions between the participants. Based on a cross-verification of the coded data of these sources (cf. data triangulation), a list of ideas for the functionalities of the game was formulated to inspire and guide further design efforts.

Building on the solutions found in the prototyping sessions, we were able to concretize the insights resulting from phase 1 and 2. For instance, we had learned the importance of prolonged motivation. Now we learned *how* we could increase motivation (cf. section 4 for more results). The different ideas were implemented and reworked into the first working demonstrator of the MELoDiA game, which was tested in the following phase.

3.3 Phase 4: Evaluation (Month 13)

3.3.1 Participants

In the evaluation phase, we involved experienced music learners to evaluate the music game in relation to music education. Due to a change in partners, we engaged younger children (aged 6 to 10) than in the previous phases to fit the new content target group. Also, we wanted to avoid negative evaluation of the demonstrator instilled solely by the children's disliking of the game's content (cf. Gagné's nine events of instruction). Next to different preferences, cognitive development (cf. Piaget, 1977) of this age group might differ from children that participated in the previous sessions (i.e. 8 - 12 years old). During evaluations, for instance, one 6-year-old experienced difficulties with fluently reading the lyrics.

We organized two evaluation sessions in two music schools, with 16 children. Seven children taking piano lessons, aged 9 to 10, participated in the first evaluation session and nine children learning to play the flute, aged 6 to 9, in the second one. To make the setting less intimidating for the children, we organized the evaluation in groups of two to three participants. Two researchers (i.e. one moderator and one note-taker) guided each group through the session.

3.3.2 Procedure

First, the children were invited to explore two existing music games (i.e., 'Piano Dust Buster 2' and 'The Voice' (see figure 10)) on a tablet that resembled the MELoDiA game (i.e., immediate feedback, popular content).

(insert figure 10)

Figure 10. Screenshot of second reference game (copyright Starmaker Interactive Inc.)

By setting a playful atmosphere we created an open environment for critical reflection and provided a frame of reference for evaluation. Then, the children were asked to perform specific tasks with the MELoDiA game: select a song, practice the lyrics, interpret feedback and perform a song. Figure 11 depicts the evaluation set-up and an impression of the game's song performance mode. At the end, the researchers asked the participants about their views on the goal of the game and whether they felt that they had learned something. The sessions lasted 30 to 45 minutes each.

(insert figure 11)

Figure 11. Evaluation set-up showing practice mode

3.3.3 Analysis

The researchers' observation notes were summarized in Excel sheets in a dedicated tab, related to the different tasks. We focused on usability issues, interpretation of feedback and the estimated learning outcomes. This resulted in 13 adaptations regarding the usability of the music game (e.g. text is shown too fast to read), and indications that the game might support learning (cf. section 4 for more results).

4 Results

In this section, we discuss the research outcomes in relation to the main features of the music game and the theoretical elements discussed earlier. We also indicate their impact on the design process. In table 2, we present an overview of

all conceptual elements, their origin, the findings, their impact on the game design, and relation to the corresponding subsections of the results section.

4.1 Educational feedback loop

4.1.1 Insight

Children valued clear, accurate feedback. Positive and negative feedback are acceptable, when it supports personal improvement. In the co-design sessions, the children suggested different forms of feedback, like festive cheering. Many participants were eager to learn and acquire music skills. Hence, they wished to be evaluated extensively when playing educational music games: *"You can't learn, if you don't know what you're doing wrong"* (C11F06).

4.1.2 Design impact

The game provides detailed feedback on the performance in different ways (see table 2). The consortium had long discussions about making clear that the users were playing an *educational* game. They feared the children would not perceive the end-product as a game. However, this finding influenced the decision to provide detailed feedback after singing (so children can look at the mistakes they made), next to real-time feedback.

4.2 Rewarding progress and commitment

4.2.1 Insight

In the interviews and co-design sessions, we learned that the majority of the children attributed a negative connotation to practicing; especially when they have to repeat continuously, complete complex exercises or receive no assistance. Many participants expressed they needed scores to support their

learning process. Participants of the co-design sessions indicated that obtaining high scores is crucial for motivation as this rewards their commitment to learning music. The majority of the children considered scores as a reward in itself: *"Getting good scores is fun!"* (C08F04).

4.2.2 Design impact

Discussions revolved around whether scores should be central in the game since an educational partner was opposed to scoring. Based on the input from the PD research process, however, we included a scoring system. To address possible frustration related to not scoring (enough) points, the game's scoring structure also includes points for commitment and persistence.

4.3 Chunking

4.3.1 Insight

Many children mentioned that making short exercises and practicing chunks of music helps improving their performance and lowers the threshold towards learning music. The interviews and co-design sessions affirmed that mini-games within the music game could facilitate this: *"small games have to be included. Otherwise, it might become a little boring…"* (C04F02).

4.3.2 Design impact

The game assists learners in practicing songs in chunks in three different ways. First, mini-games for detailed and thorough practice were envisioned and worked out from the beginning. Second, in the practice mode we made sure to clearly mark the structure of the song – verse, refrain, and bridge – to delineate

these ‘chunks’ in an easy, clear manner. Third, the children can practice one song in different ways (e.g. only text or vocals without music).

4.4 Autonomy

4.4.1 Insight

Throughout the PD process, we learned that the children choose not to play a game when they dislike the content. Moreover, many children indicated that they should be able to choose how, what, and when to learn. For instance, when presented with the idea of a 'music coach' (that would point out content based on their previous performances) children reacted negatively. Also, when playing the proxy-game (cf. phase 2), one girl mentioned that she found an alternative way to prepare for more difficult songs: *“Then I discovered that I could return to the easy songs. So I played those to practice for the hard song instead”* (C05F03).

4.4.2 Design impact

The music game allows the users to structure their own learning experience. The music game supports the children’s autonomy, because children can choose the song and parts they want to practice.

4.5 Private practice, public performance

4.5.1 Insight

Most children feel insecure when learning music and consider it a 'private' matter. They wish to use the application privately, without the presence of others. The vulnerability that is associated with the possibility of failure requires a safe ‘failing’ environment, which a game can provide. Characteristic for acquiring musical skills is that children want to 'show off' skills they have

acquired and mastered. During the interviews and co-design sessions, the children expressed that they would like to play together or compete with peers as well as share high scores or good quality recordings: *"I would like to share it, so someone else can listen to it as well. Like my grandma for instance"* (C16F10). However, children only want to share those performances that they find deserving of an audience.

4.5.2 Design impact

The consortium directed its attention to creating an audience for the user, yet maintaining a 'safe' environment. The game is divided in different modes: in the practice mode children can improve their skills while in the performance mode, they go on stage in front of a virtual audience that grows in number if they perform well. Furthermore, users can record (and replay) their performances.

4.6 Free play

4.6.1 Insight

Most children were excited about the possibility to improvise and manipulate songs. For example, one child stated: *"I like to sing my songs in a made-up language"* (C10F06). Some mentioned that they would like to write their own lyrics or remix a song themselves. Participants in the co-design sessions even dreamed about writing their own scores. Generally speaking, there was a strong interest in improvisation and exploration among the participants.

4.6.2 Design impact

Given the limited project duration (i.e. one year and a half), the consortium could not focus on free play. Instead, they worked on the analysis of user feedback and the practice mode of the game.

(Insert Table 2)

Table 2. Overview of the findings

5 Discussion

In this discussion we focus on the presented research outcomes to inspire and guide designers of future digital music games. In designing this game, we have dedicated most attention to providing a feedback loop to the children (e.g. during singing, detailed analysis after singing, mini-games for directed practice). The deliberate focus on feedback and instruction was meant to support an independent learning process. It mirrors the strategies children recognize from music education, while focusing on the *individual* child and supporting the child's motivation (i.e. freedom of choice, autonomy, rewarding effort). This combination is expected to leverage good learning results when playing the music game. Considering that the evaluation of the music game was short-term, it is not possible to demonstrate the intended learning outcomes. To this end, a long-term evaluation is required.

Next to user insights related to the theoretical framework, we gathered two important insights relevant for digital music learning. First, based on SDT (i.e. relatedness) we explored the possibility to learn together. However, we noticed

that children need a 'safe' environment. By practicing *without* others listening, children can overcome insecurities at the beginning of the learning process. Only when children feel they have progressed, they are keen to share their abilities and compete with peers. The design of our game only affords offline sharing and competition. It remains to be studied how these interactions can be facilitated and incorporated into digital music learning. This might be especially important to study with older teens (13+) that use social networks regularly. Secondly, we found an important opportunity related to musical creativity in relation to the practiced songs. Our participants indicated creativity should be considered as an integral part of the music learning process. We were unable to explore the design of musical creativity within the technical and time constraints of this project, but believe this is an important opportunity that merits further exploration in future research.

6 Conclusion

Throughout this paper, we have presented the PD process of the development of a digital educational music game for primary school children. We engaged the target group to gain a deeper understanding of children's expectations towards digital music games. We described how the employed theoretical framework was translated into design requirements for educational music games that address the needs of young music learners. Based on our findings we conclude that the design of educational digital music games can adequately support children in learning how to sings songs they know and like. Furthermore, it seems opportune to design digital music games to support creative learning outcomes.

It is within this creativity space we see important opportunities for serious games to make a difference in music learning.

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7 Bibliography

Bamford, A. (2007). *Kwaliteit en consistentie. Kunst- en cultuureducatie in Vlaanderen*.

Becker, K. (2007). Pedagogy in Commercial Videogames. In D. Gibson & C. Aldrich, *Games and Simulations in Online Learning: Research and Development Frameworks* (pp. 21–48). Hershey, PA: Idea Group Inc.

Bleumers, L., Naessens, K., & Jacobs, A. (2010). How to approach a many splendoured thing: Proxy Technology Assessment as a methodological praxis to study virtual experience. *Journal For Virtual Worlds Research*, *3*(1), 24.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.

Denis, G., & Jouvelot, P. (2005). Motivation-Driven Educational Game Design: Applying Best Practices to Music Education. Presented at the ACE, Valencia.

Druin, A. (2002). The role of children in the design of new technology. *Behaviour & Information Technology*, *21*(1), 1–25.

Duysburgh, P., Slegers, K., Mouws, K., & Nouwen, M. (2015). Playful Sounds From The Classroom: What Can Designers of Digital Music Games Learn From Formal Educators? In *Proc of CHI*. New York: ACM Press.

Ehn, P., & Badham, R. (2002). Participatory Design and the Collective Designer. In *Proceedings of the Participatory Design Conference* (pp. 1–10).

Fails, J. A., Guha, M. L., & Druin, A. (2012). Methods and Techniques for Involving Children in the Design of New Technology for Children. *Human–Computer Interaction*, *6*(2), 85–166.

Flick, U. (2009). *An Introduction to Qualitative Research* (4th ed.). London: Sage.

Gagné, R. M. (2005). *Principles of instructional design*. Belmont, CA: Thomson/Wadsworth.

Gee, J. P. (2007). *What video games have to teach us about learning and literacy*. New York: Palgrave Macmillan.

Green, L. (2009). *Music, Informal Learning and the School: A New Classroom Pedagogy*. Ashgate Publishing, Ltd.

Guha, M. L., Druin, A., & Fails, J. A. (2013). Cooperative Inquiry revisited: Reflections of the past and guidelines for the future of intergenerational co-design. *International Journal of Child-Computer Interaction*, *1*, 14–23.

Hanna, L., Neapolitan, D., & Risden, K. (2004). Evaluating computer game concepts with children. In *Proceedings of IDC* (pp. 49–56). New York: ACM.

Iivari, N., Kinnula, M., & Kuure, L. (2015). With best intentions: A Foucauldian examination on children's genuine participation in ICT desig. *Information Technology & People*, *28*(2), 246–280.

Iversen, O. S. (2005). *Participatory Design Beyond Work Practices – Designing with Children* (PhD Dissertation). University of Aarhus, SE.

Khaled, R., & Vasalou, A. (2014). Bridging serious games and participatory design. *International Journal of Child-Computer Interaction*, *2*, 93–100.

Kujala, S., Roto, V., Väänänen-Vainio-Mattila, K., Karapanos, E., & Sinnelä, A. (2011). UX curve: a method for evaluating long-term user experience. *Interacting with Computers*, *23*(5), 473–483.

Lamont, A., Hargreaves, D. J., Marshall, N. A., & Tarrant, M. (2003). Young people's music in and out of school. *British Journal of Music Education*, *20*(03), 229–241. http://doi.org/10.1017/S0265051703005412

Meyer, D. Z., & Avery, L. M. (2009). Excel as a Qualitative Data Analysis Tool. *Field Methods*, *21*(1), 91–112.

Miller, G. A. (1956). The Magical Number Seven, Plus or Minus Two: Some Limits on our Capacity for Processing Information. *Psychological Review*, *63*, 81–97.

Muller, M. (2002). Participatory design: the third space in HCI. In J. Jacko & A. Sears (Eds.), *The Human-Computer Interaction Handbook: fundamentals, evolving techniques and emerging applications* (pp. 1051–1068). Hillsdale: Lawrence Erlbaum Associates.

Norman, D. A. (2009). THE WAY I SEE IT: Memory is more important than actuality. *Interactions*, *16*(2), 24–26.

Peppler, K., Downton, M., Lindsay, E., & Hay, K. (2011). The Nirvana Effect: Tapping Video Games to Mediate Music Learning and Interest. *International Journal of Learning and Media*, *3*(1), 41–59.

Piaget, J. (1977). *The Essential Piaget*. (H. E. Gruber & J. J. Voneche, Eds.). New York: Basic Books.

Prensky, M. (2007). *Digital game-based learning*. St. Paul, Minn.: Paragon House.

Read, J. C., Fitton, D., & Horton, M. (2014). Giving ideas an equal chance: inclusion and representation in participatory design with children. In *Proceedings of the 2014 conference on Interaction design and children* (pp. 105–114).

Read, J. C., Gregory, P., MacFarlane, S., Mcmanus, B., Gray, P., & Patel, R. (2002). An Investigation of Participatory Design with Children - Informant, Balanced and Facilitated Design. In *Proceedings of Interaction Design and Children International Workshop*. Shaker Publishing.

Ronimus, M., & Lyytinen, H. (2015). Is school a better environment than home for digital game-based learning? The case of Graphogame. *Human Technology*, *11*(2), 123–147.

Russell-Bowie, D. (2008). MMADD about the arts!: an introduction to primary arts education. Pearson Education Australia.

Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *CoDesign*, *4*(1), 5–18.

Silverman, D. (2010). *Doing qualitative research* (Third edition). London: Sage.

Sim, G., Vissers, J., Nouwen, M., Horton, M., Slegers, K., & Zaman, B. (in press). Using the MemoLine to Capture Changes in User Experience Over Time with Children. *International Journal of Child-Computer Interaction*.

Vaajakallio, K., Mattelmäki, T., & Lee, J. J. (2010). "It became Elvis" – Co-design lessons with Children". *Interactions Magazine*, *July/August*, 26–29.

Van Mechelen, M., Gielen, M., vanden Abeele, V., Laenen, A., & Zaman, B. (2014). Exploring Challenging Group Dynamics in Participatory Design with Children. In *Proceedings of the 2014 Conference on Interaction Design and*

Children (pp. 269–272). New York, NY, USA: ACM. http://doi.org/10.1145/2593968.2610469

Van Mechelen, M., Laenen, A., Vanden Abeele, V., & Zaman, B. (2015). Challenging Group Dynamics in Participatory Design with Children: Lessons from Social Interdependence Theory. In *Proc of IDC* (pp. 219–228). New York: ACM.

Visser, F. S., Stappers, P. J., van der Lugt, R., & Sanders, E. B.-N. (2005). Contextmapping: experiences from practice. *CoDesign*, *1*(2), 119–149.

Vissers, J., De Bot, L., & Zaman, B. (2013). MemoLine: evaluating long-term UX with children. In *Proc. IDC 2013* (pp. 285–288). New York: ACM.